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Geoscientific Model Development Discussions

Interactive comment on "Use of agricultural statistics to verify the internannual variability in land surface models: a case study over France with ISBA-A-gs" *by* J.-C. Calvet et al.

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Reviewer #1

The authors thank the anonymous reviewer #1 for his/her review of the manuscript and for the fruitful comments.

1.1 [Clarification of objectives - Because the model used in the study, ISBA-A-gs, does not include any crop-specific parameterisation, the authors are assuming that the processes that govern variability in the yield of crops are the same as those that govern variability in unmanaged vegetation biomass accumulation. This assumption should be stated more clearly in the paper. Crops and grasslands are photosynthesising veg-

etation biomes so this assumption is clearly not completely invalid. However, crops have been chosen, bred and are managed, to produce high yields of grain, at optimum quality, with optimum use of resources. Therefore, there are several reasons to expect that variability in yield may not be perfectly correlated with the annual maximum biomass of "natural" vegetation. Given this discrepancy between the nature of the simulated and observed variables, the stated objective of the paper is "to assess to what extent this information [agricultural statistics] can be used to validate a generic LSM". This is a worthy aim but I do not think it is answered in this paper. At the beginning of the Conclusions section the authors state that "agricultural statistics were used to assess to what extent the ISBA-A-gs land surface model is able to reproduce the interannual variability of the dry matter yield". I think that the difference between these two statements is important and needs clarification to improve the clarity of the paper. The second statement is much closer to what was done in the paper. I suggest that the initial objective is rewritten as it is not possible to answer without a second, independent, observational data set of vegetation productivity which is more directly comparable to the modelled variables.]

RESPONSE 1.1 Yes, the authors agree that the objectives could be more clearly described, in the Introduction Section. The sentences cited by Reviewer #1, could be rephrased as: "The objective is to assess to what extent agricultural statistics (crop yields and fodder production) can be used to assess the capability of a generic LSM to reproduce the interannual variability of the dry matter yield. Indeed, ISBA-A-gs is able to represent the climate impact on the main biophysical processes using a limited number of equations and parameters, but ISBA-A-gs does not include any crop-specific parameterisation and is not able to simulate the crop grain yield formation per se. Moreover, the processes that govern variability in the yield of crops are not exactly the same as those that govern variability in unmanaged vegetation biomass accumulation, and while ISBA-A-gs simulates the climatic impacts on photosynthesis and on the vegetation growth, specific factors impacting the agricultural production are not accounted for. The latter include changes in the intensity of the crop management (in relation

to technical advances or public policies), pests, diseases, migration of a given crop type from productive to poorer lands, or (in the case of cereals) the grain formation. Also, crop cultivars have been bred to produce high yields of grain, at optimum quality, with optimum use of resources. Therefore, variability in crop yield may not be perfectly correlated with the annual maximum biomass of more "natural" vegetation types."

1.2 [Grasslands vs. crops - The authors show that significant correlations are found between simulated vegetation biomass and crop/grassland yield in some regions. A major conclusion is that the variability of grasslands are better captured than croplands. Is this surprising given the lack of a specific crop representation in ISBA-A-gs ? Or is it because the grassland observations are in fact simulated values themselves and that the STICS formulation could be similar to that in ISBA-A-gs ? A more thorough discussion of these points is needed.]

RESPONSE 1.2 The two explanations are valid. The fact that the yield variability is better captured for grasslands than for croplands can be explained by (1) the lack of a specific crop representation in ISBA-A-gs, (2) the use of a model (STICS) to produce the ISOP fodder production index. Although the STICS formulation is quite different from ISBA-A-gs, the comparison of two models generally produces less scatter than comparing a model with measurements performed in the real world. Indeed, any model is based on assumptions and cannot fully represent the spatial and the temporal variability of the modelled variables, especially at the regional scale addressed in this study.

1.3 [Grasslands vs. crops - I was astonished to see in the Conclusions that the authors think that "the model could probably be improved by representing managed grasslands", despite finding that "a striking result is the excellent scores obtained for managed grasslands". Surely, this would argue for concentrating on improving the representation of crops, not grasslands?]

RESPONSE 1.3 Yes, the Conclusion sentence could be rephrased as : “In this study, a

simple method based on a LAI threshold was used for the first time in ISBA-A-gs to represent managed grasslands. The excellent scores obtained with this new option of the model shows that this parameterization could be used in future studies or applications. Also, a better mapping of MaxAWC is needed. ”

1.4 [Justification for the optimisation of MaxAWC - In my understanding, MaxAWC is a property of the plants and soil and so I expected a value to be determined a priori from datasets such as ECOCLIMAP. In fact, the final paragraph of page 1481 seems to suggest this is possible. Instead, the authors use this parameter to tune the model. The same simulations are then used to evaluate the model performance. Ideally, any tuning should be done independent of validation.]

RESPONSE 1.4 While, for a given vegetation type, MaxAWC values can be derived from the default soil characteristics provided by ECOCLIMAP, the uncertainties affecting MaxAWC (in particular soil depth) are very large. This is why a large range of MaxAWC values are investigated in this study (see Sect. 2.4): although ideally any tuning should be done independently from the validation, using a wrong MaxAWC value may trigger discrepancies in the simulated vegetation biomass and lead to wrong conclusions regarding the intrinsic model performance.

1.5 [Clarity of benchmarking protocol - The paper fails to completely deliver on the GMDD evaluation criteria that in benchmarking papers it should be possible for the protocol to be precisely reproduced for an independent model. The description was mostly good but it was not clear to me how the aggregation of 8km simulations within each département unit was performed. Perhaps adding to my confusion is that the circles in Fig 1 (left) are referred to as SAFRAN grid cells in the figure caption, but as départements in the text (page 1483, line 21).]

RESPONSE 1.5 The explanation given at the end of Sect. 2.1 could be completed with the following sentence: “The ISBA-A-gs simulations are performed for given sites, corresponding to 8km x 8km grid-cells of the SAFRAN atmospheric forcing database.

Each site is representative of one administrative unit (“département”) and corresponds to the SAFRAN grid-cell covering the ECOCLIMAP-II grid-cell presenting the highest fraction of either C3 crops or grasslands. This procedure permits to ensure that the meteorological variables used to drive the model are consistent with the main location of the croplands (grasslands) within a département. At these sites, the C3 crop or grassland patches represent at least 45% of the ECOCLIMAP-II grid cell. For a given département, the meteorological data of the SAFRAN site(s) are used to drive the model. In general, one site (corresponding to either C3 crops or grasslands) per département is studied, but for some départements (e.g. Puy-de-Dôme), two sites are described, one for grasslands, and one for C3 crops”.

1.6 [page 1480, line 10: "verification of the hypothesis made in SURFEX on the value of MaxAWC" You do not mean hypothesis. You are evaluating the default choice of parameters in the model.]

RESPONSE 1.6 Yes, this sentence could be reworded as: “An important aspect of the validation is the verification of the default choice of parameters in SURFEX on the value of the Maximum Available soil Water Content (MaxAWC), on photosynthesis parameters, and on specific plant responses (avoiding or tolerant) to drought.”

1.7 [page 1480, line 14: why did you not also consider maize?]

RESPONSE 1.7 A large proportion (more than 40%) of the maize grain production in France comes from irrigated fields, and irrigation tends to reduce the impact of the climate interannual variability on the vegetation biomass and on the grain yield (Debaeke and Bertrand, 2008). This triggers a rather poor correlation between the maize yield statistics and the simulated vegetation biomass (Calvet et al., 2008). Moreover, the maize yield figures given by Agreste do not separate irrigated from rainfed maize over the whole period considered in this study. REFERENCE Debaeke, P., and Bertrand, M.: Évaluation des impacts de la sécheresse sur le rendement des grandes cultures en France, Cahiers Agricultures, 17 (5), 437-443, doi: 10.1684/agr.2008.0230, 2008.

1.8 [page 1481: it would be nice to be able to see the drought parameterisation.]

RESPONSE 1.8 Yes. A new Figure adapted from Calvet (2000) will be included in the final version of the paper.

1.9 [page 1486, line 17: why was the preliminary parameter sensitivity study only performed for one site?]

RESPONSE 1.9 A parameter sensitivity study for two contrasting sites, presenting markedly different a priori MaxAWC values, will be included in the final version of the paper.

1.10 [page 1487, line 1: the lack of sensitivity to ThetaC could be because you kept MaxAWC at 120. I’d expect that the optimised values of these parameters are correlated.]

RESPONSE 1.10 ThetaC is non-dimensional and corresponds to a scaled AWC value (i.e. the ratio AWC / MaxAWC). As such, ThetaC should not depend much on the value of a prescribed MaxAWC value. In order to check that, a parameter sensitivity study for two contrasting sites, presenting markedly different a priori MaxAWC values, will be included in the final version of the paper.

1.11 [page 1486, line 10: "the main factor", can you present any justification for this statement?]

RESPONSE 1.11 It can be shown that the simulated annual maximum Bag, at the end of the growing season, is correlated with the simulated AWC value at a given stage of the growing season. In the case of the Puy-de-Dome simulations of cereals and unmanaged grasslands (Figs. 4 and 5, respectively), the best correlations are obtained with the average monthly AWC values simulated in May, with RËĘ2 values of 0.64 and 0.57, respectively.

1.12 [Technical comments]

RESPONSE 1.12 These editorial issues will be addressed when preparing the final version of the paper. In particular, the following references, missing in the reference list of the GMDD version, will be added:

Durand, Y., Brun, E., Merindol, L., Guyomarc'h, G., Lesaffre, B., and Martin, E.: A meteorological estimation of relevant parameters for snow models, Ann. Glaciol., 18, 65–71, 1993.

Durand, Y., Giraud, G., Brun, E., Merindol, L., and Martin, E.: A computer-based system simulating snow-pack structures as a tool for regional avalanche forecasting, Ann. Glaciol., 45, 469–484, 1999.

Martin, E., Le Moigne, P., Masson, V., Boone, A., Bogatchev, A., et al.: Le code de surface externalisé SurfEx de Météo-France, Atelier de modélisation de l'atmosphère, 16–18 January 2007, Toulouse, 2007.

Quintana-Segui, P., Le Moigne, P., Durand, Y., Martin, E., Habets, F., Baillon, M., Canellas, C., Franchisteguy, L., and Morel, S.: Analysis of near surface atmospheric variables: Validation of the SAFRAN analysis over France, J. Appl. Meteorol. Clim., 47, 92–107, 2008.

Smith, P. C., Ciais, P., Peylin, P., De Noblet-Ducoudré, N., Viovy, N., Meurdesoif, Y., and Bondeau, A.: European-wide simulations of croplands using an improved terrestrial biosphere model: 2. interannual yields and anomalous CO2 fluxes in 2003, J. Geophys. Res., 115, G04028, doi:10.1029/2009JG001041, 2010a.

Smith, P. C., De Noblet-Ducoudré, N., Ciais, P., Peylin, P., Viovy, N., Meurdesoif, Y., and Bondeau, A.: European-wide simulations of croplands using an improved terrestrial biosphere model: phenology and productivity, J. Geophys. Res., 115, G01014, doi:10.1029/2008JG000800, 2010b.

Interactive comment on Geosci. Model Dev. Discuss., 4, 1477, 2011.